A NEW TECHNIQUE TO EXTRACT OPTICAL PROPERTIES OF THE WATER FROM ENVIRONMENTAL PARAMETERS

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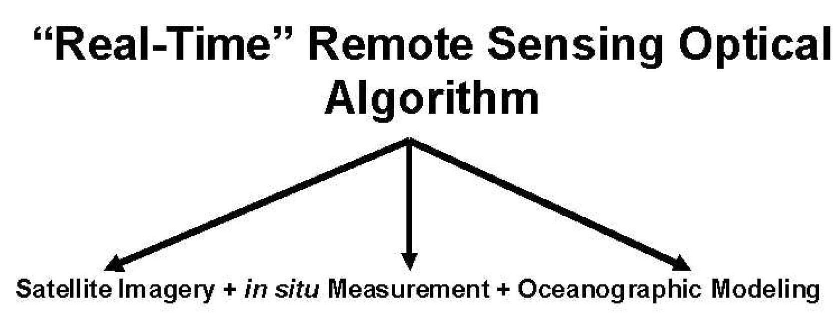
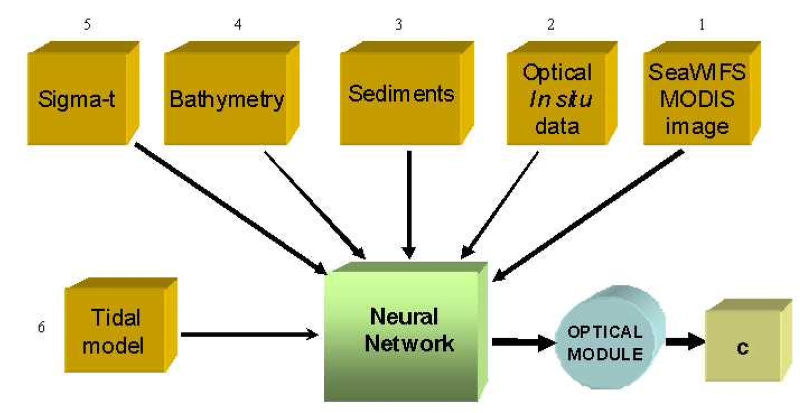
Abstract

In this poster we report on the development of a real-time environmental model to extract spectral light attenuation coefficient from the surface to the bottom of the Yellow Sea. It illustrates a technique that can be useful in the extraction of optical parameters in highly turbid and optically complex coastal areas. The model which is based on a back propagation neural network algorithm, is trained on optical and oceanographic parameters collected at various locations in the Yellow Sea from 1996-2000. It relies for its real-time estimations on tidal currents from a tidal model (ADJOINT) and temperature and salinity from a statistical model (MODAS) that produces real time estimations of these parameters at any depth around the world. Sediment and bathymetry databases provide measures of particle distribution and depth. The model can ingest satellite data but is not a requirement for its operation. The introduction of satellite data produces more accurate estimates around river outflows. However, access to clear data is limited in the Yellow Sea due to persistent cloudiness and fog. The accuracy of the model increases with the amount and variety of the input data. The best estimates occur in coastal areas.

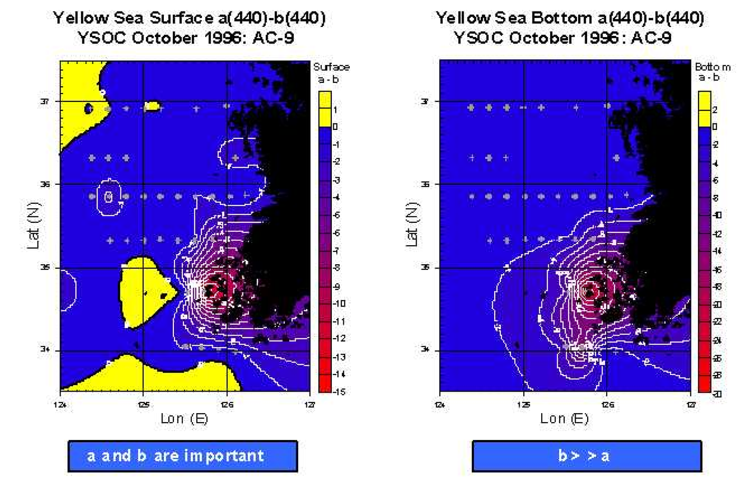
The Algorithm



Architecture of the Yellow Sea Optical Model

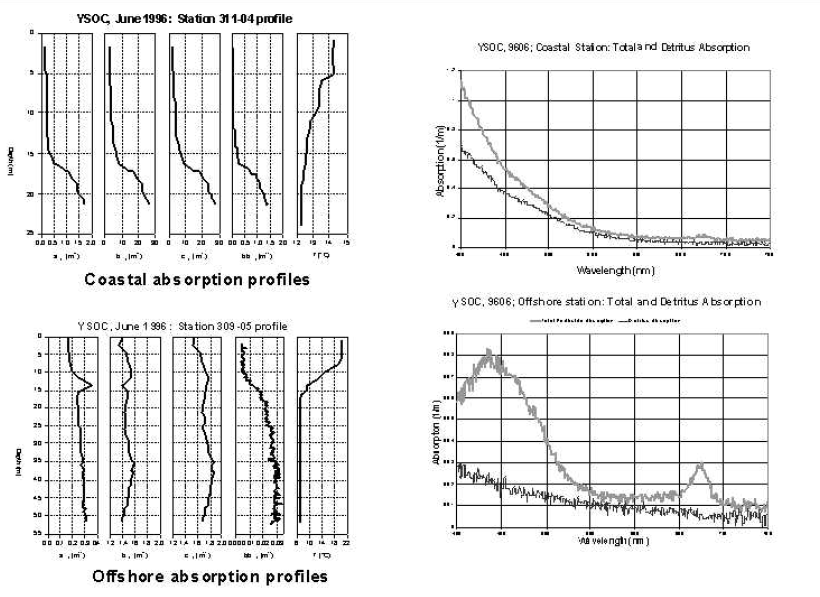


Surface and bottom optical environments of the Yellow Sea

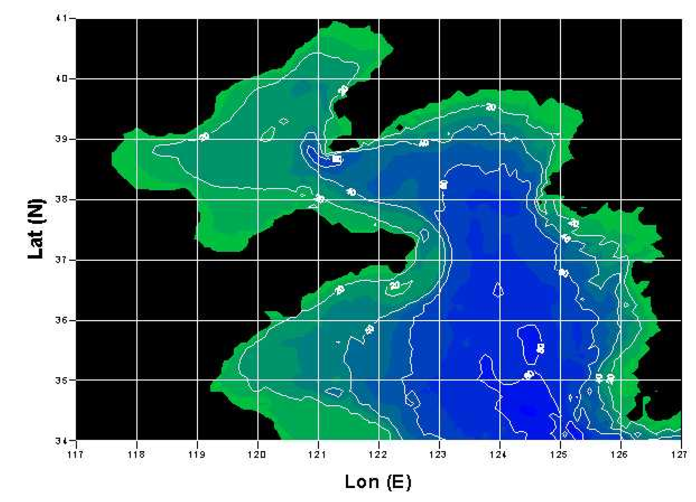


The Yellow sea is dominated by particle scattering in response to tidal forces. Exceptions are isolated spots at the surface in the center of the Yellow Sea (yellow areas)

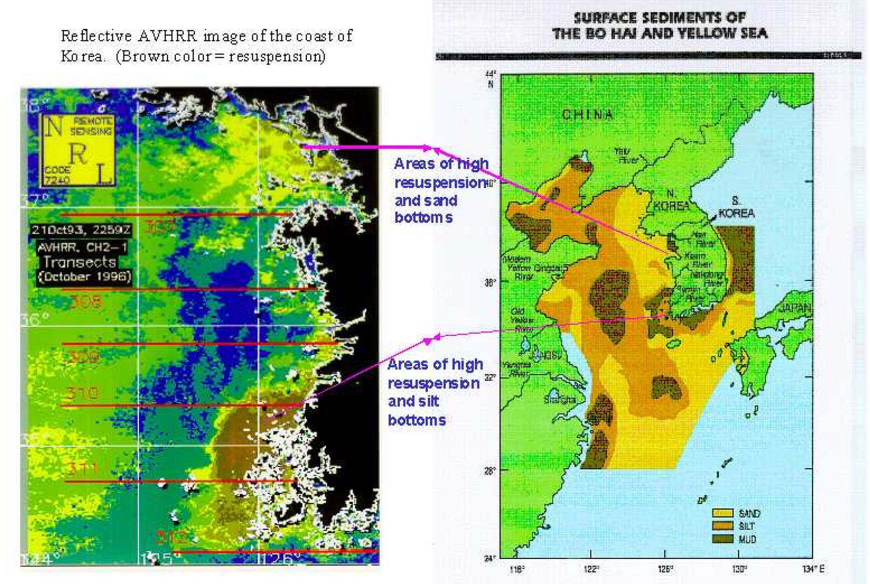
Offshore vs coastal absorption in the Yellow Sea



Bathymetry: an input to the model.

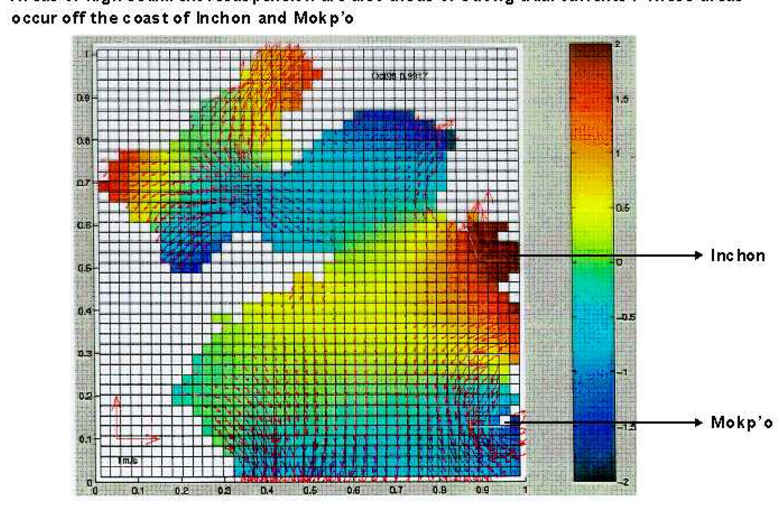


Sediment: an input to the model.



Tides: an input to the model.

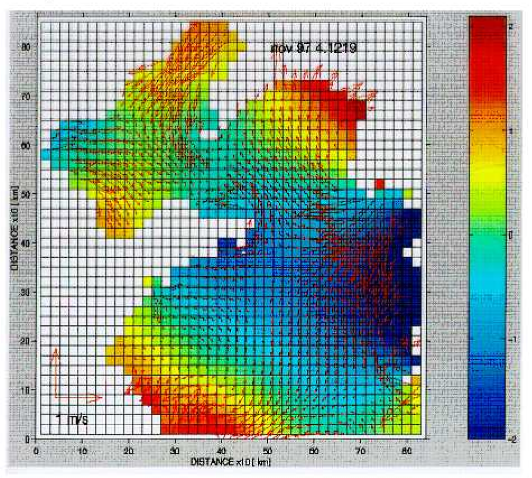
Areas of high sediment resuspension are also areas of strong tidal currents: These areas occur off the coast of Inchon and Mokp'o



This is an example of the products of the ADJOINT tidal model (Perkins) that feeds into the OPM Colors denote tidal heights. Arrows indicate current speed and direction.

Tides: an input to the model.

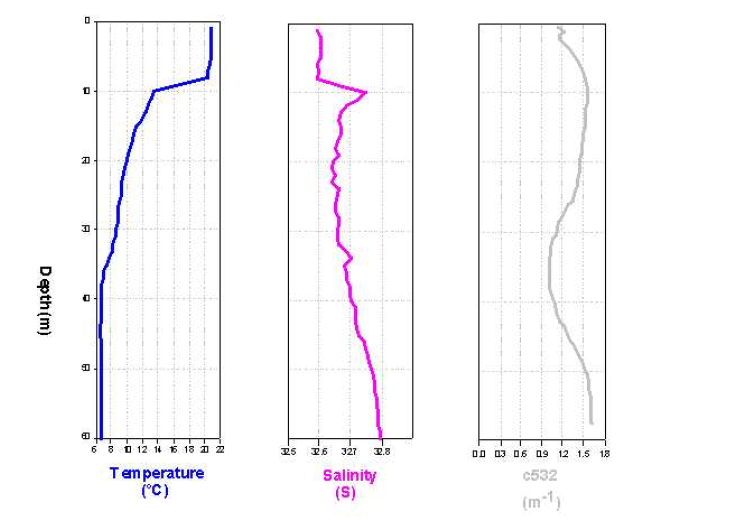
The tidal current is a Kelvin wave that propagates along the coasts of the Yellow Sea. As it propagate it changes the optical environment of the Yellow Sea.



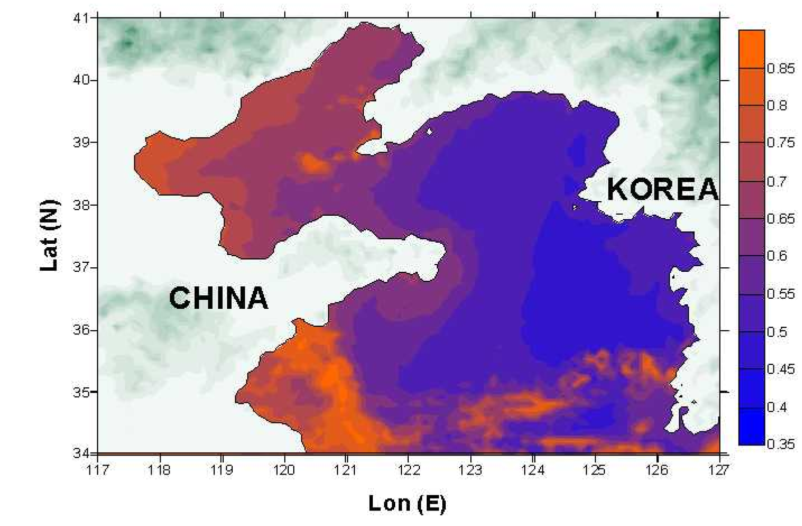
Tidal currents at 0 hours

This is an example of the products of the ADJOINT tidal model (Perkins) that feeds into the OPM Colors denote tidal heights. Arrows indicate current speed and direction.

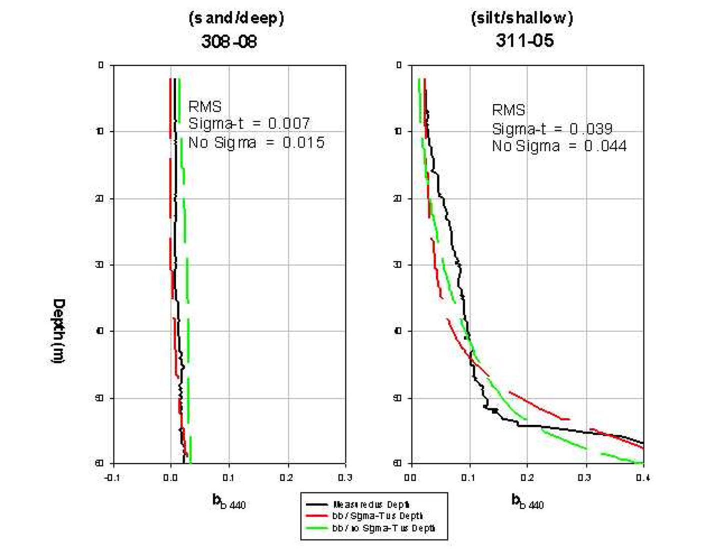
In situ optical and oceanographic data used by the neural network model



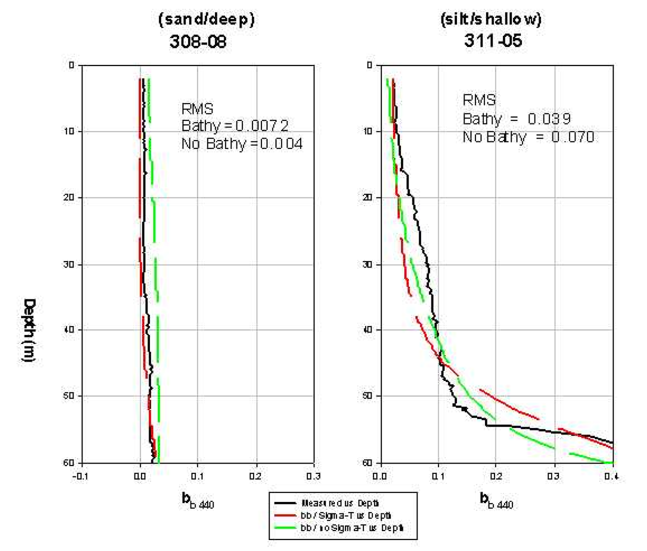
Water Leaving Radiance (SeaWiFS), an optional input to the model



Sensitivity of the model to sea water density (Sigma-t)



Sensitivity of the model to bathymetry



Results of the neural net sensitivity tests to currents

	T RMS	% error	D/S RMS	% error
trained and tested with currents	0.0135		2.06	
trained and tested without currents	0.0192	42	5.678	175
trained and tested with currents	0.0135		2.06	
trained with currents tested w/o currents	0.1217	80	17.07	727
trained and tested with correct currents	0.0135		2.06	
trained with correct currents, tested with 3-hour old current	0.0356	164	2.91	41
trained and tested with correct currents	0.0135		2.06	
trained with correct currents, tested with 6-hour old current	0.1539	1040	8.2	298

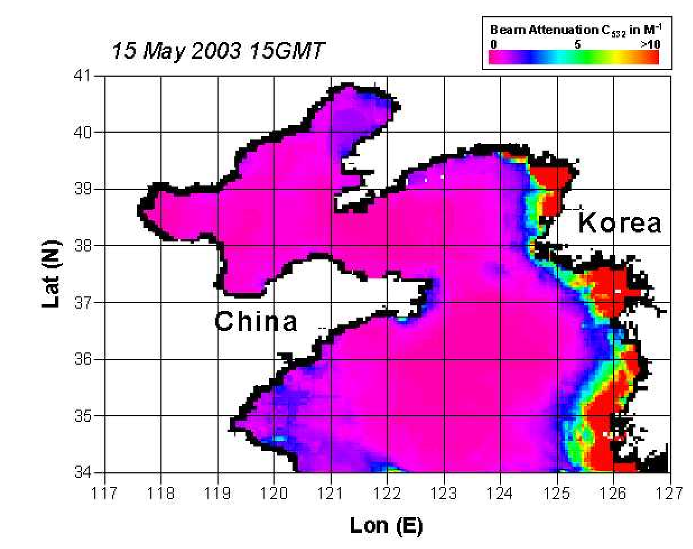
TRMS= total Root Mean Square Error
D/S RMS = Depth/surface Root mean Square Error

Samples of the model results: attenuation at depth

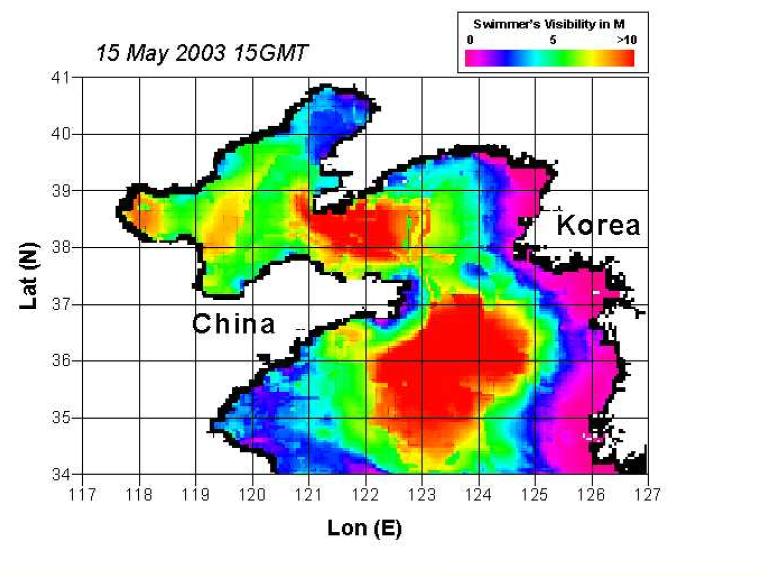
12:00 13:00

Spectral attenuation with respect to depth at noon and 13 hours

Samples of the model results: surface C_{532}



Samples of the model results: surface swimmer's visibility at 532 nm



Samples of the model results: vertical profiles of C_{532} for two stations

Performance of default algorithm (without satellite image)

Results and conclusions

- The YSOM computes spectral attenuation with respect to depth with minimal computation time and high accuracy.
- The performance of the model increases with the variety and amount of data presented to the model during the training phase.
- There is insufficient evidence to indicate that the addition of satellite data produces a better algorithm. However, there are places, such as river mouths and open waters, where the satellite data can make important contributions to the algorithm.
- Our data indicated that the model can only use satellite data within a small time frame (about an hour) around the time of the satellite acquisition.
- There is no known algorithm in or outside of the Navy that can produce better estimates of spectral attenuation coefficient with respect to depth for the Yellow Sea than the YSOM.